

**CAPS**

**Center for Applied Physics Studies**  
**Louisiana Tech University**

**NEW SEISMIC MEASUREMENTS AT LIGO  
LIVINGSTON OBSERVATORY**

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*We have had assistance setting up from Marcos Alvarez (PASSCAL at New Mexico Tech University), computer assistance from Tom Evans (LIGO Livingston Observatory), and valuable advice from Alan Rohay (Pacific Northwest National Laboratory), Kip Thorne (California Institute of Technology), and Gabriela Gonzalez (Pennsylvania State University)*

## Why New Seismic Measurements?

1. The construction of the site is finished:
  - better positioning of the instrumentation.
2. More and better sensors available:
  - old: CMG-40T, sensitivity 800 V/m/s
  - new: CMG3-ESP, sensitivity 2000 V/m/s
  - new: four sensors available simultaneously
  - new: limit of the sensitivity at low frequencies decreased by an order of magnitude.
3. Hope for better and more precise description of the LIGO site ambient ground vibration.

# PASSCAL Sensor Comparison

**OLD:**

CMG-40T	Guralp	50 ma @ 12vdc	0.033 Hz	0.707 critical	800 v/m/s	two at zero	-0.1481 +0.1481i -0.1481 -0.1481i
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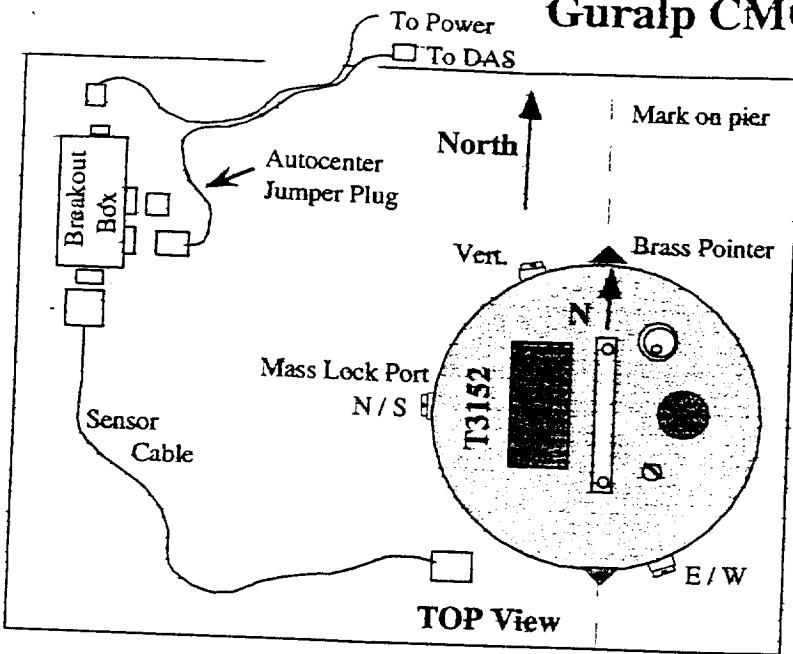


**NEW:**

CMG3-ESP	Guralp	100 ma @ 12vdc	0.033 Hz	.707 critical	2000 v/m/s	two at zero	-0.147 +0.147i -0.147 -0.147i
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# Guralp CMG-3 ESP



**Channel Order**  
 (positive voltage on DAS channel means ground moved in given direction)

- 1 Up
- 2 North
- 3 East

**Sensitivity**  
 2000 Volts / meter / second

**Calibration constant**  
 1 volt input ~ 1 volt output

**Typical DAS parameters:**

**Gain** 1  
**Cal Amplitude** 0.10 Volts  
**Cal Interval** 90  
**Cal Step Size** 91

## Physical Characteristics:

**Size** cylinder 16.8 cm diameter, 38 cm height  
**Weight** 14 kg.  
**Shipping Weight** 65 lbs. **Size** 13x13x24 inches (Gbox)  
**Power consumption**  
 100 mA @ 12 VDC  
 pulses of 400 mA required for centering

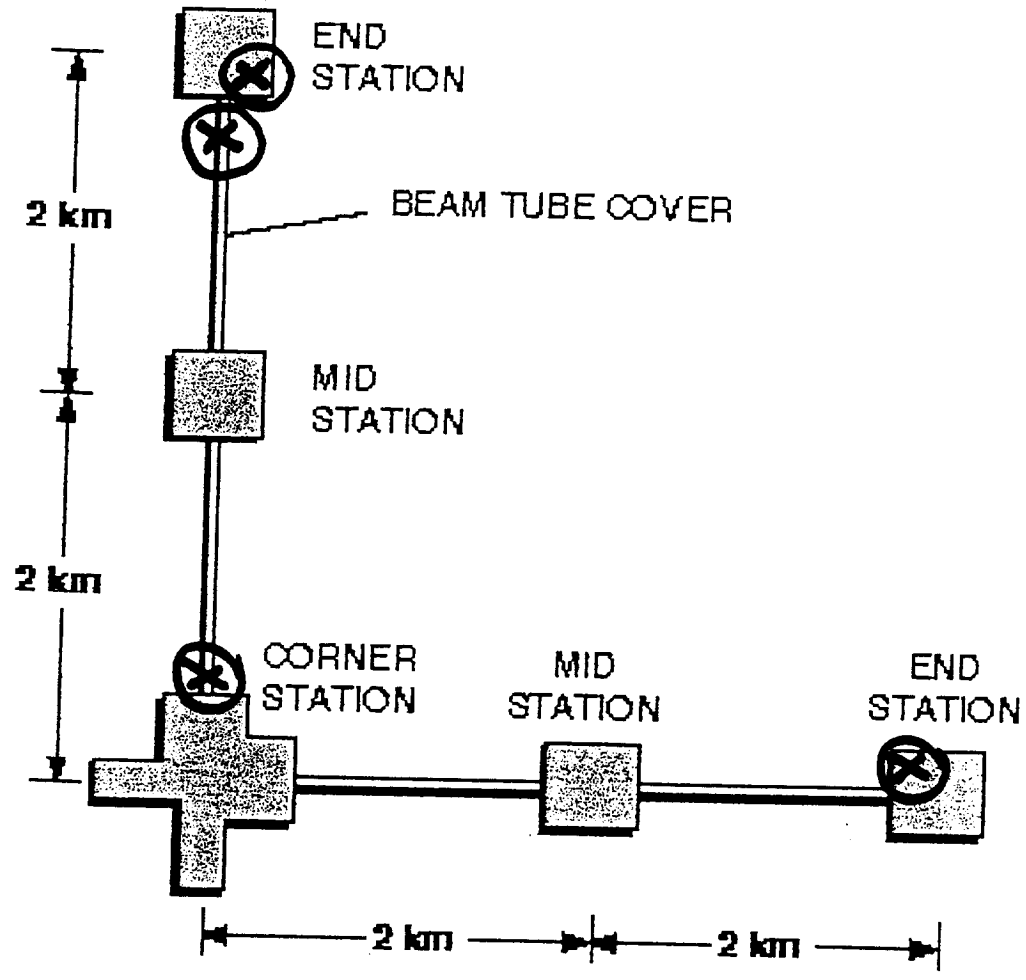
## Frequency Response:

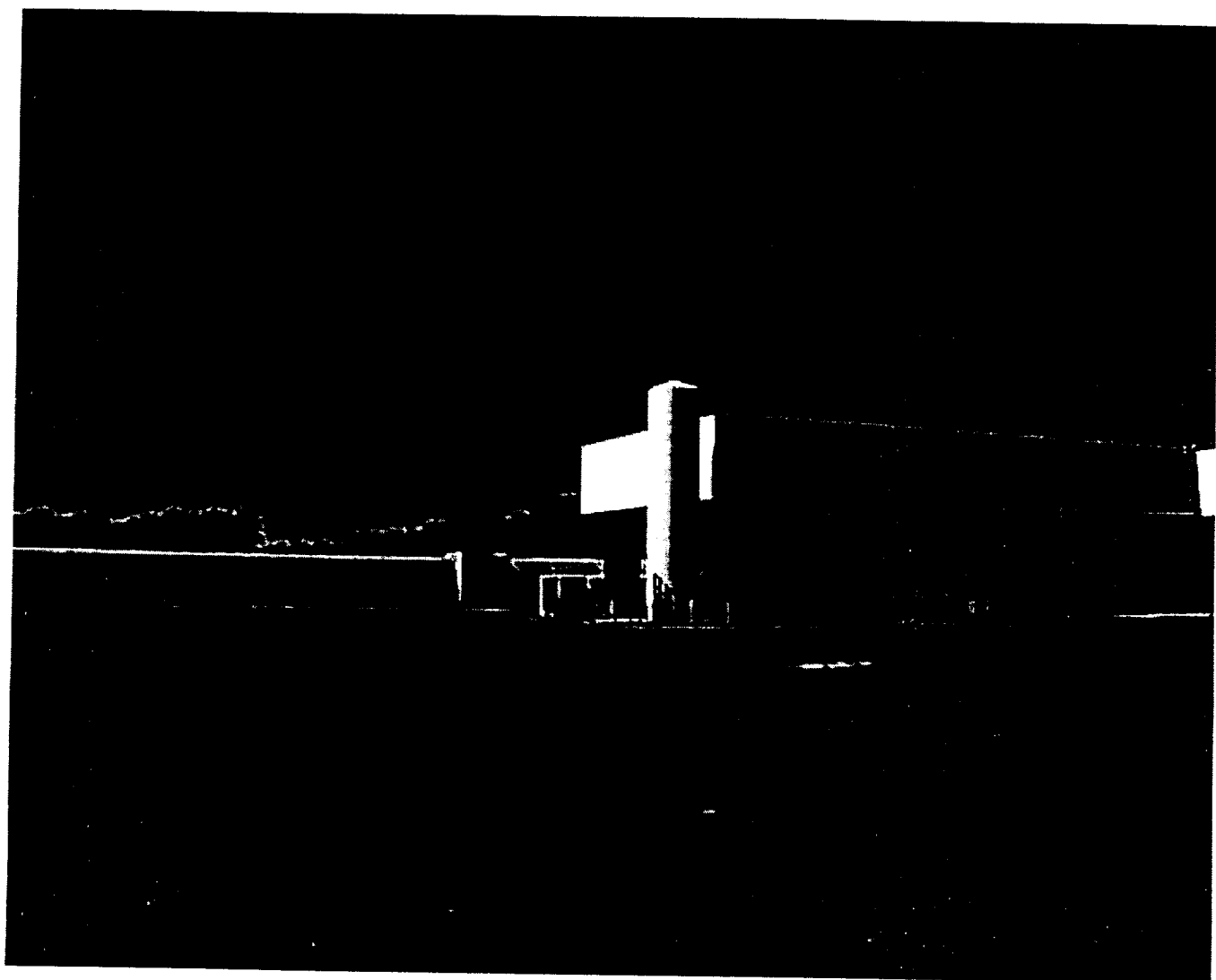
**Natural Freq.** 0.033 Hz. (30 seconds)  
**Damping** 0.707 critical  
**Zeros** two at zero  
**Poles** -0.147 + 0.147i  
 -0.147 - 0.147i

## GÜRALP SENSOR SPECIFICATION SUMMARY

FEATURE	CMG-1	CMG-3	CMG-40	CMG-5
Standard Bandwidth	0.0027-50Hz (360-0.02 sec)	0.01-50Hz (3T) 0.03-50Hz (3ESP)	0.03-50Hz	dc-100Hz flat to acceleration
Alternate Bandwidth	0.00833-50Hz 0.01-50Hz 0.033-50Hz USNSN Response 0.005-50Hz	0.0027-50Hz 0.00833-50Hz 0.01-50Hz 0.033-50Hz USNSN Response 0.005-50Hz	0.016-50Hz 0.00833-50Hz	dc to 80Hz flat to acceleration
Masslock	Remote	Remote (3T) Manual (3ESP)	Not required	Not required
Centring	Remote	Remote (3T) Remote (ESP)	Manual	Manual
Cal. Input	Remote	Remote	Remote	Remote
Mech. Resonance	>140Hz	>140Hz	>400Hz	>450Hz
Temperature Sensitivity	<3V/10°C	<3V/10°C	<0.6V/10°C on low gain channel	<0.005V/10°C for low gain channel
Operating	-10 to 65°C	10 to 65°C	10 to 65°C	10 to 65°C

# POSITIONS:





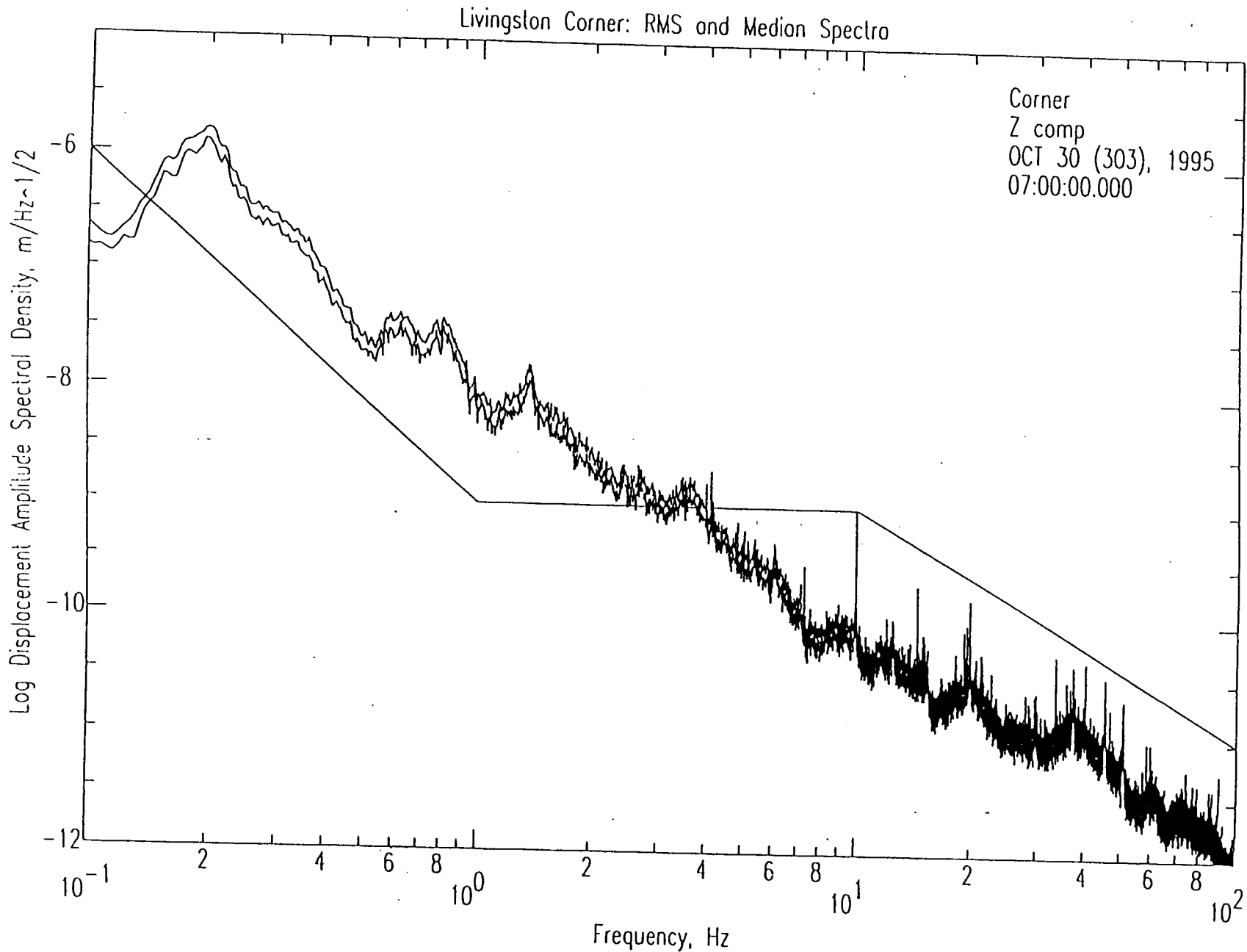
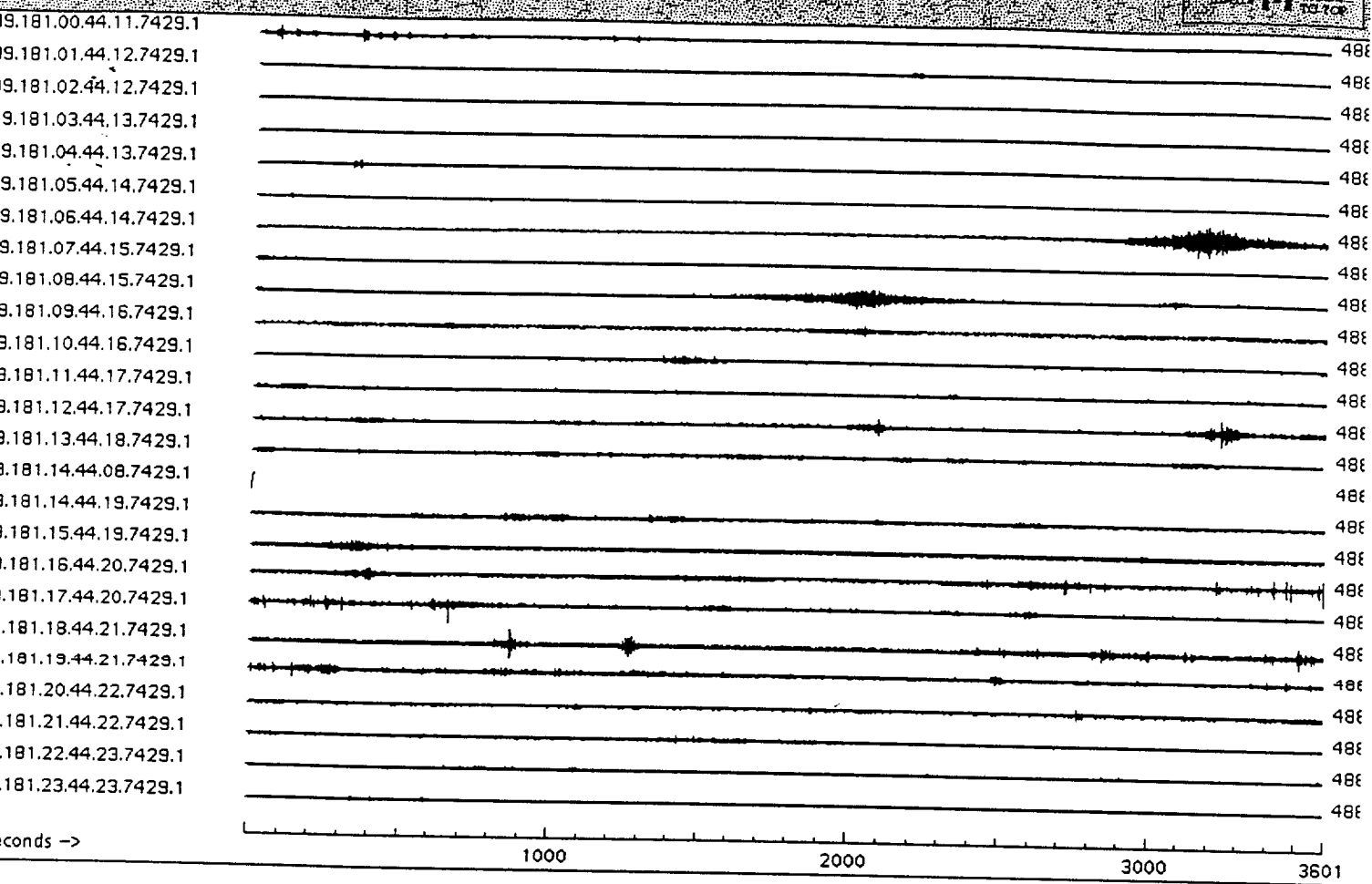


Figure 6-1., Amplitude spectra (median and r.m.s.) for a quiet one-hour period at the Corner. This period corresponds to the spectrogram shown in Figure 5-1. Vertical component is shown.

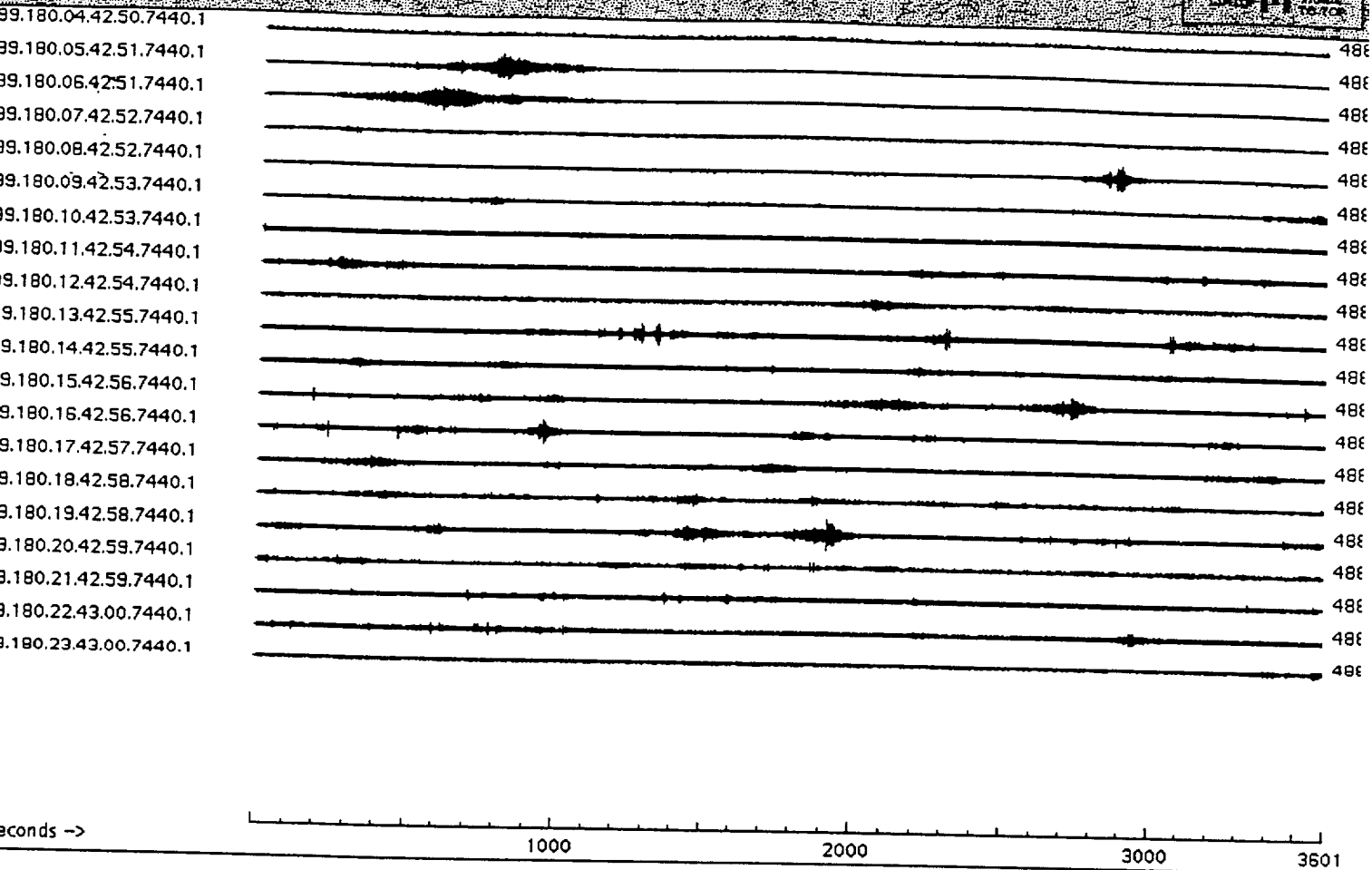
Alan Rohay, Pacific Northwest National Laboratory

(Next) (Prev) (Controls) (Select All) (Deselect All) (Magnify) (Spectra) (Waveforms) (Set Defaults) (About Act.)  
 Scale by: (Trace) (Window) In: (Volts) (Counts) (Sort Traces) (Quit)

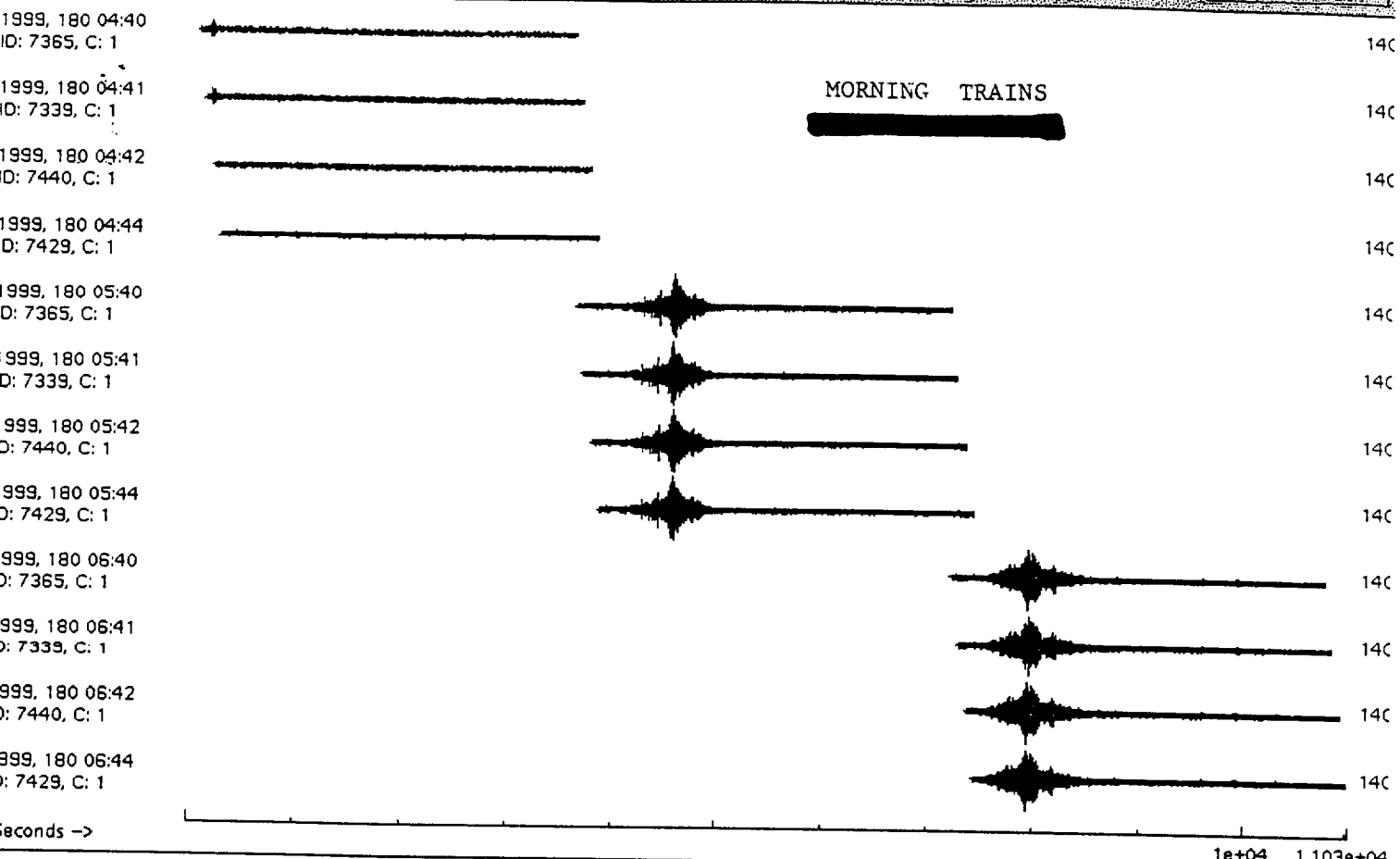


Unit 7429, Ch. 1., Year 99. Day 181, 24 Hours of Data

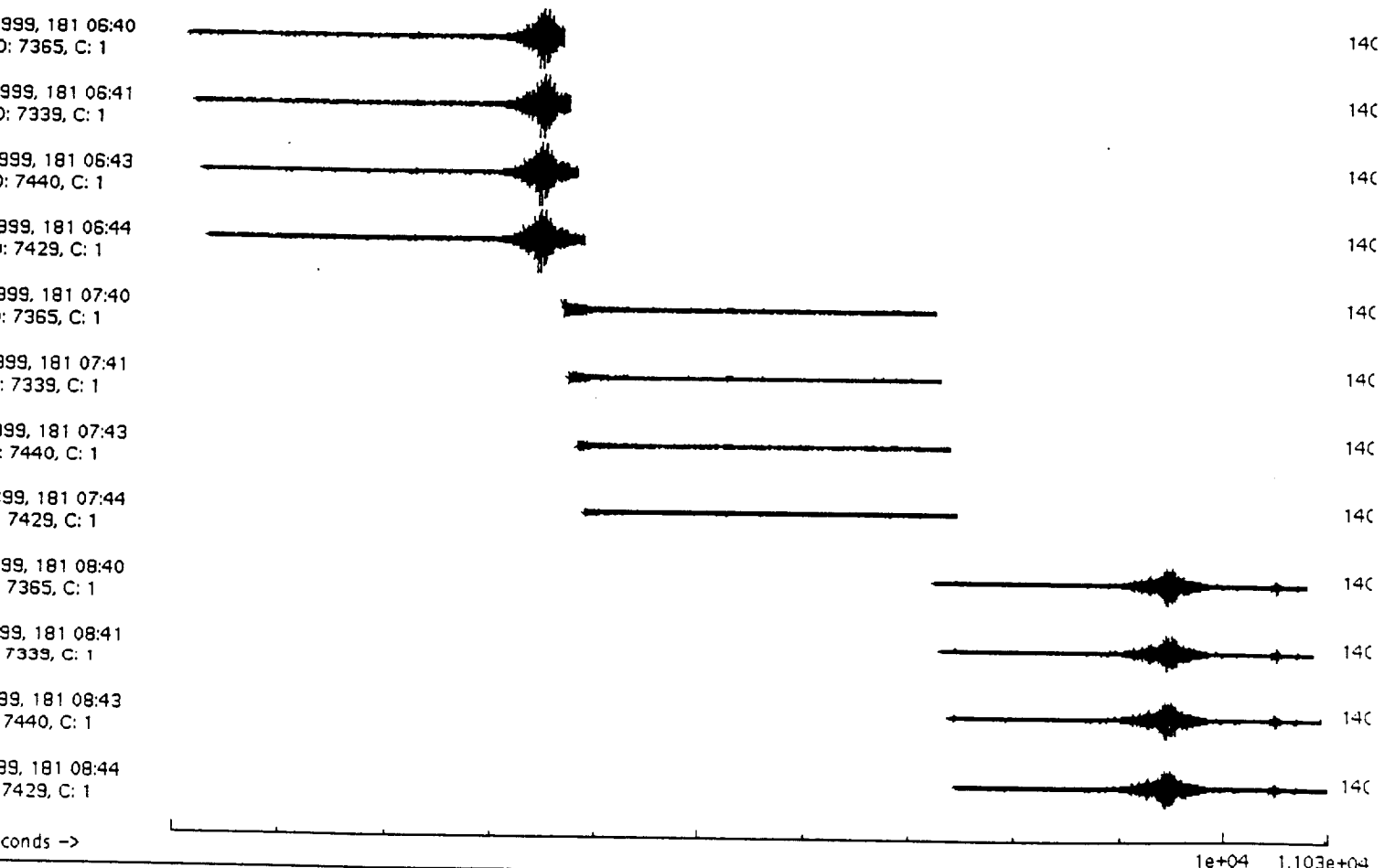




Unit 7440, Ch. 1., Year 99, Day 180, 20 Hours of Data



MORNING TRAINS



Time Absolute scale by: Trace Window Inc. Y-axis Counts

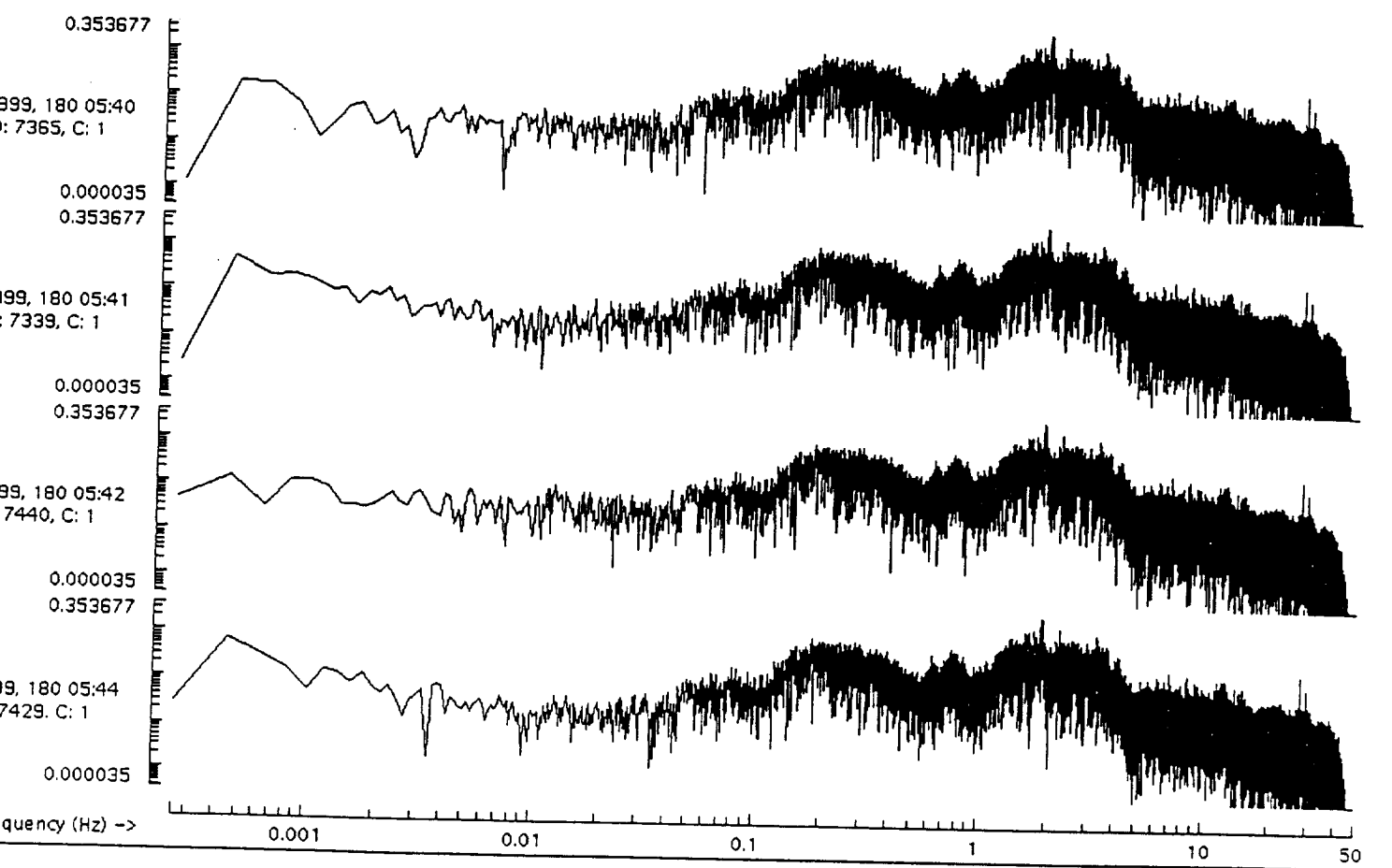
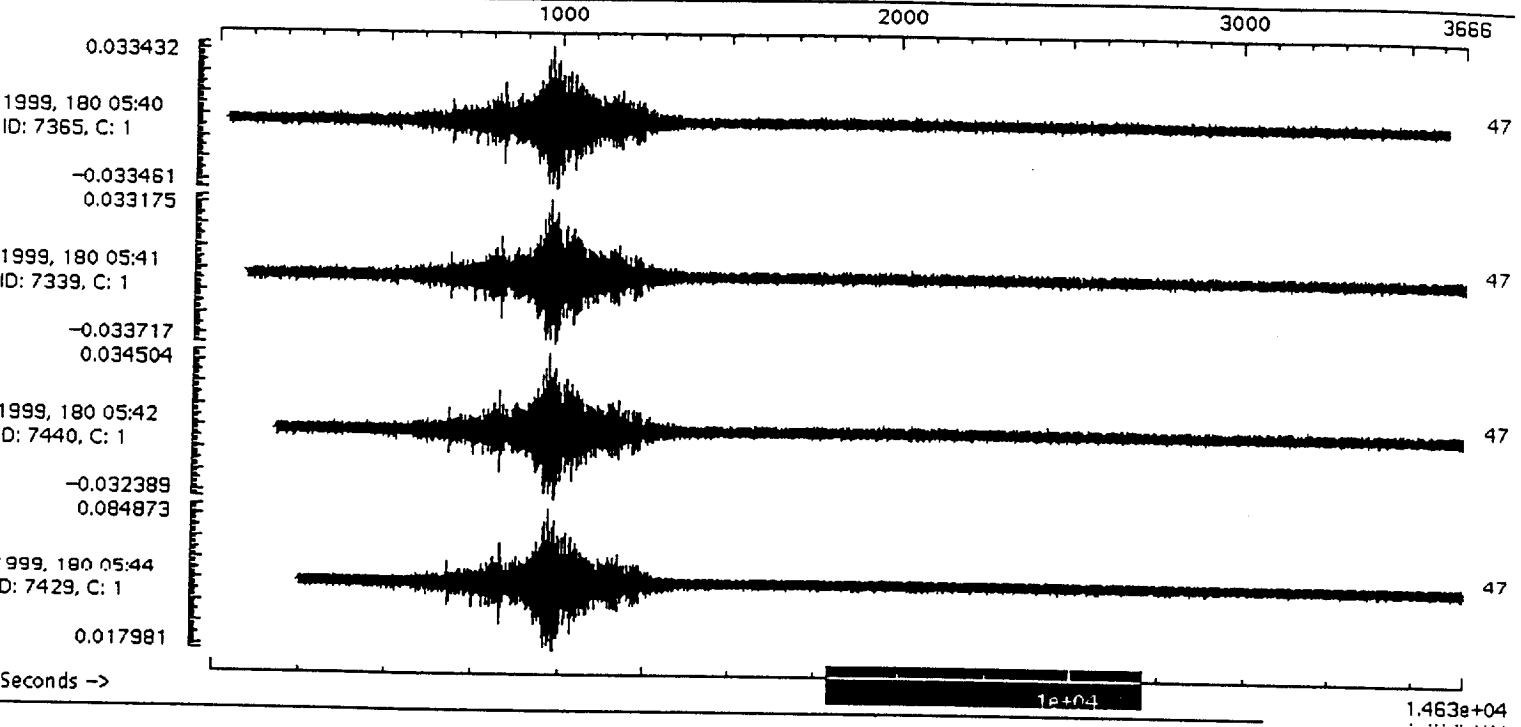
Control: Overlay/Regular Filter/Regular Filter Off

← → Zoom Out

Screen Dump Spectra Return

Marine Photo  
VOLUME  
DATE

MORNING TRAIN, SHORT TERM  
DATA AND POWER SPECTRUM



OLD DATA.

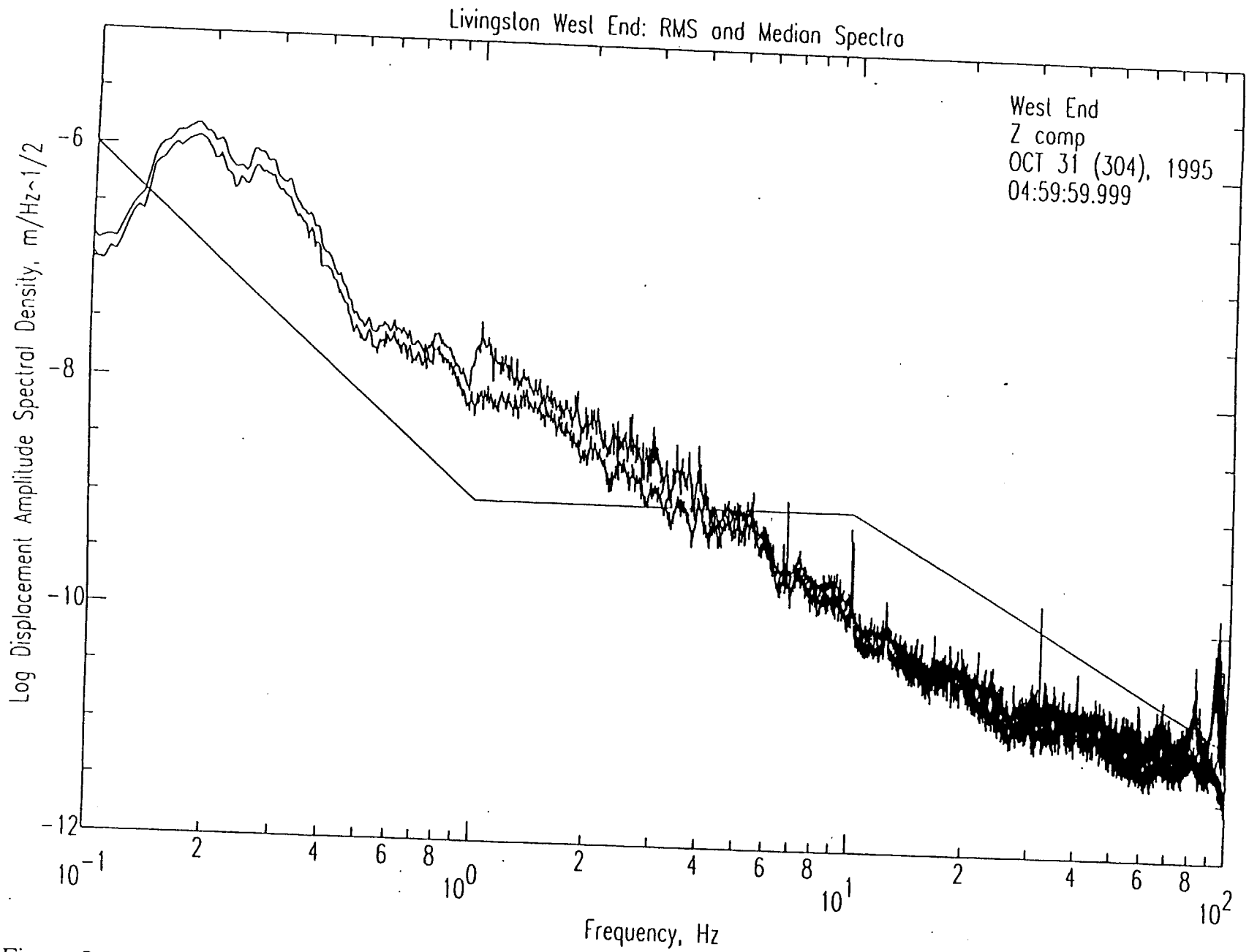


Figure 9.1-5. Amplitude spectra (median and r.m.s.) for a one-hour period at the West End when a train passed south of the site. Alan Rohay, Pacific Northwest National Laboratory

*Note 1, Linda Turner, 08/17/99 08:37:28 PM*  
LIGO-G990079-30-M